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(54) **CONFIGURABLE VIRTUAL MACHINES**

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(52) **U.S. Cl.**

CPC **G06F 9/44505** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,396,807 B1 * 3/2013 Yemini et al. 705/59
8,495,648 B1 * 7/2013 Brandwine et al. 718/104

8,595,806 B1 * 11/2013 Gabrielson 726/7
8,606,922 B1 * 12/2013 Greenfield et al. 709/226
8,627,468 B2 * 1/2014 Kakadia et al. 726/22
8,849,947 B1 * 9/2014 Artzi et al. 709/217
2004/0010592 A1 * 1/2004 Carver et al. 709/226
2005/0278441 A1 * 12/2005 Bond et al. 709/223
2007/0174410 A1 * 7/2007 Croft et al. 709/208
2008/0244607 A1 * 10/2008 Rysin et al. 718/104
2008/0301674 A1 * 12/2008 Faus 718/1
2011/0137758 A1 * 6/2011 Bienias 705/27.2
2011/0202405 A1 * 8/2011 Clark et al. 705/14.49
2011/0238460 A1 * 9/2011 Al-Dawsari et al. 705/7.31
2011/0270963 A1 * 11/2011 Saito et al. 709/224
2012/0016721 A1 * 1/2012 Weinman 705/7.35
2012/0290725 A1 * 11/2012 Podila 709/226
2012/0297188 A1 * 11/2012 van der Linden 713/165
2012/0331476 A1 * 12/2012 Saffre 718/104
2013/0007088 A1 * 1/2013 Alfredo et al. 709/201
2013/0326505 A1 * 12/2013 Shah 718/1

* cited by examiner

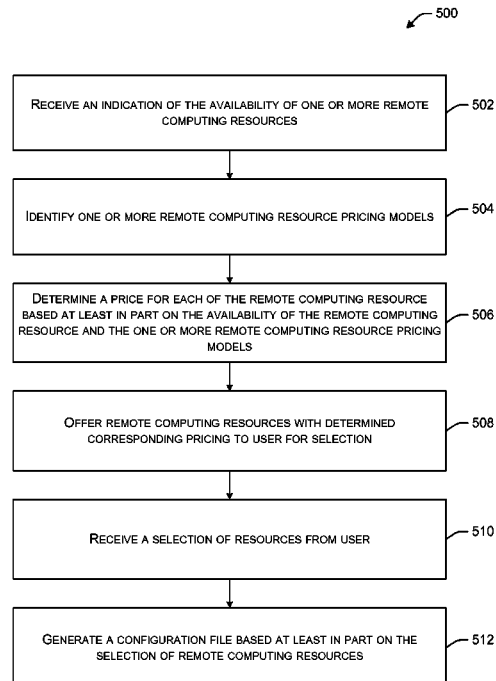
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(57) **ABSTRACT**

Systems and methods for configuring a virtual machine provided by a remote computing system based on the availability of one or more remote computing resources and respective corresponding prices of the one or more remote computing resources.

25 Claims, 9 Drawing Sheets



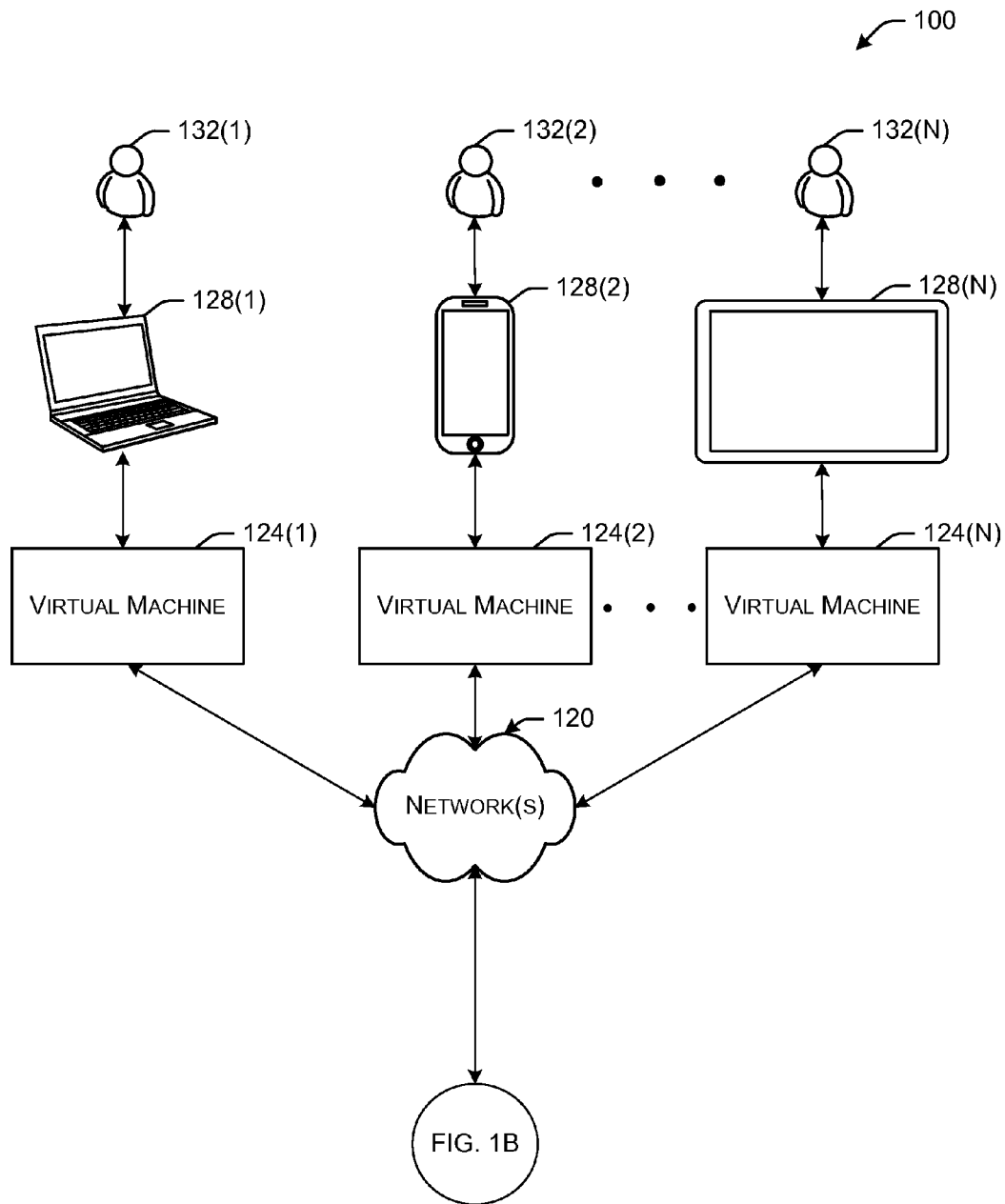


FIG. 1A

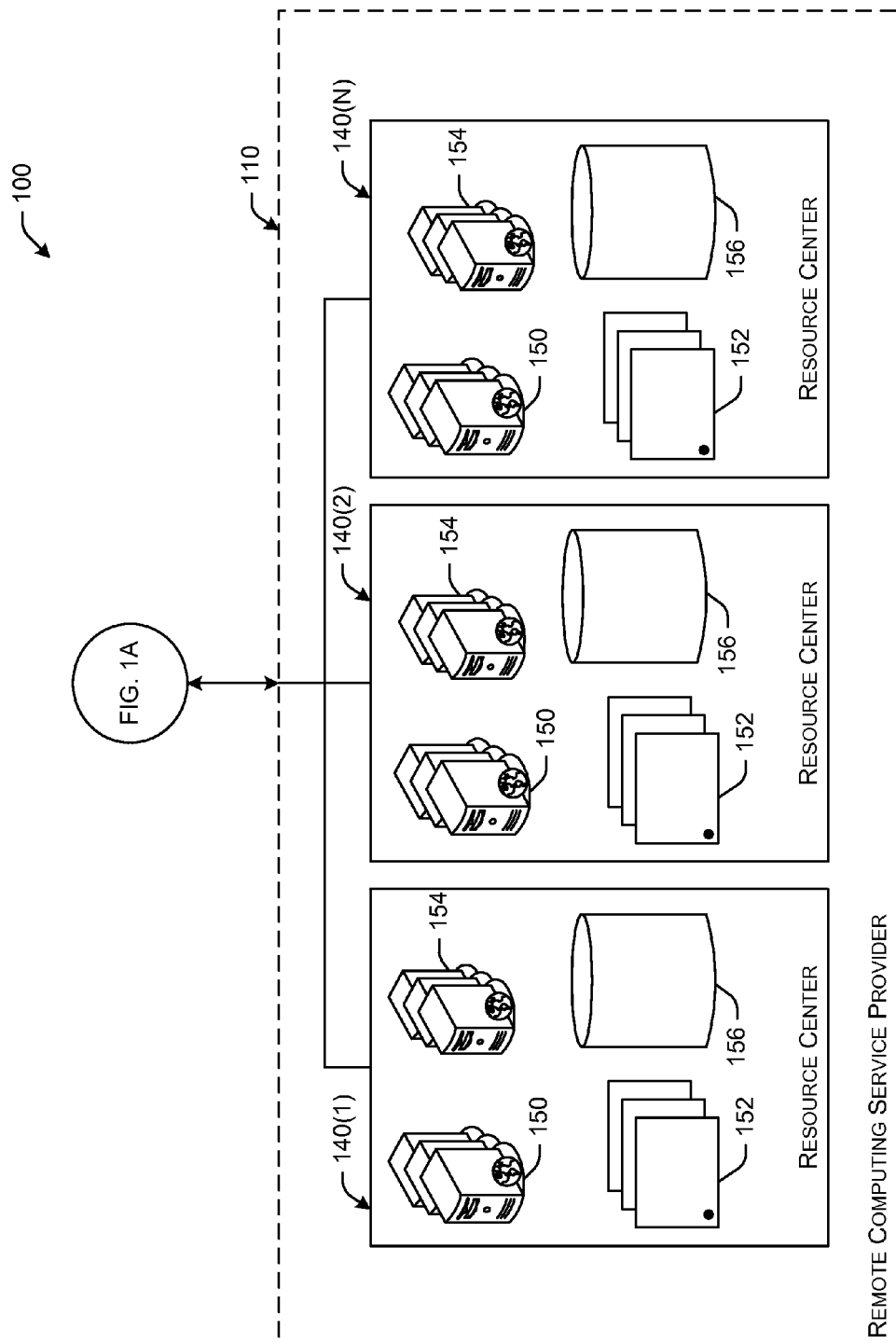


FIG. 1B

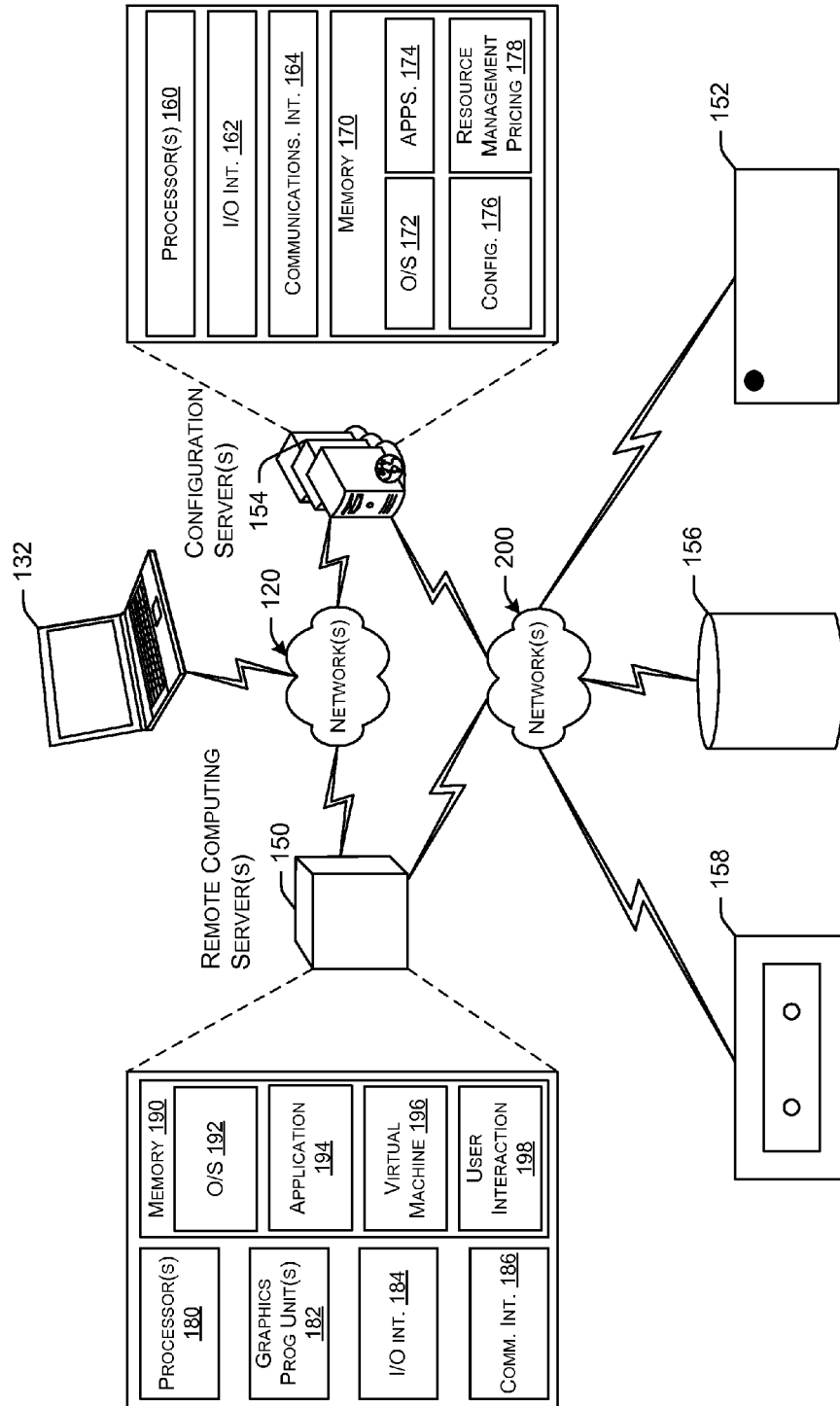


FIG. 2

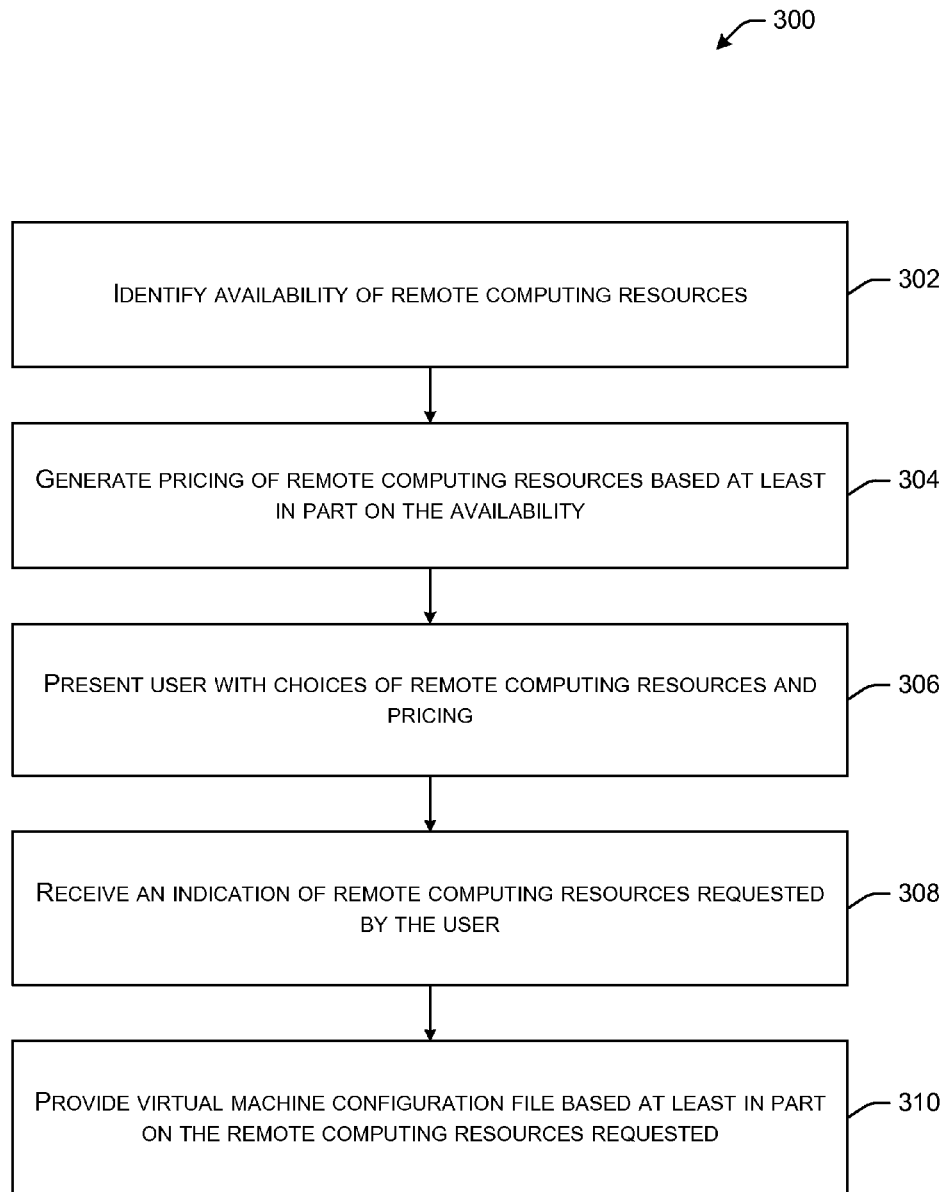


FIG. 3

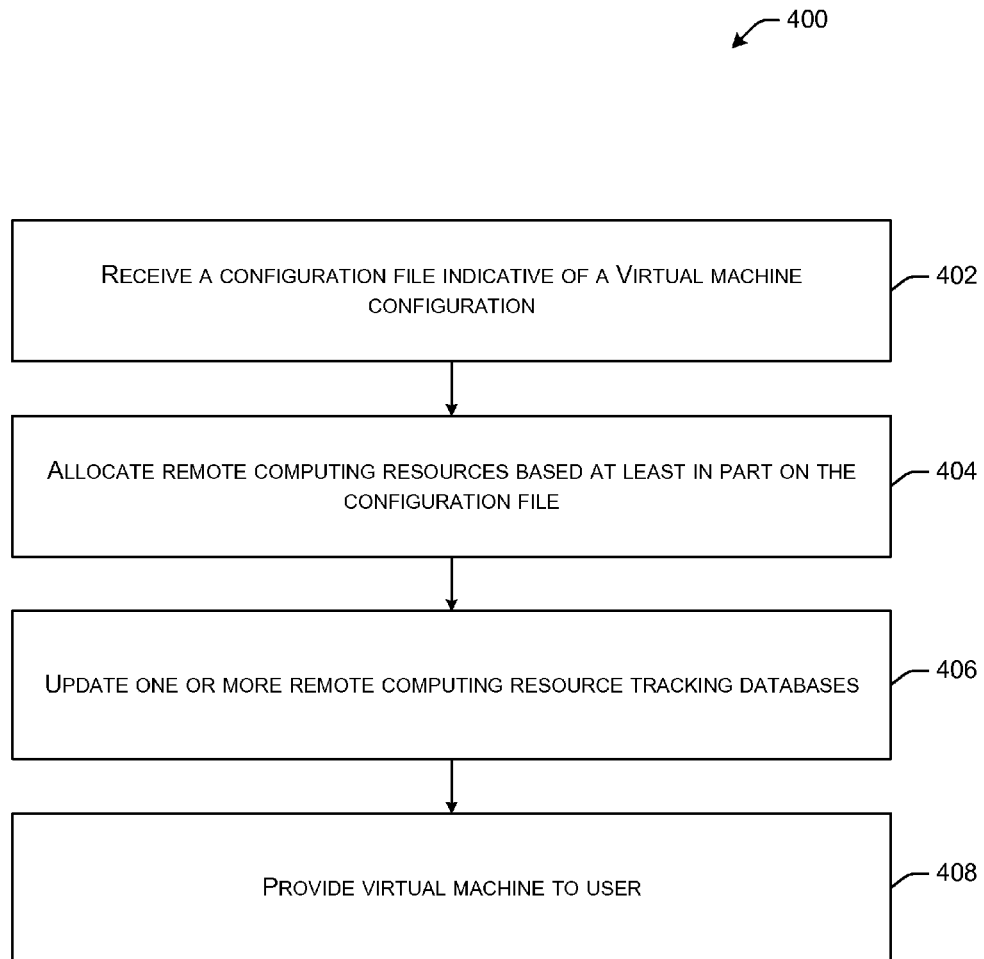


FIG. 4

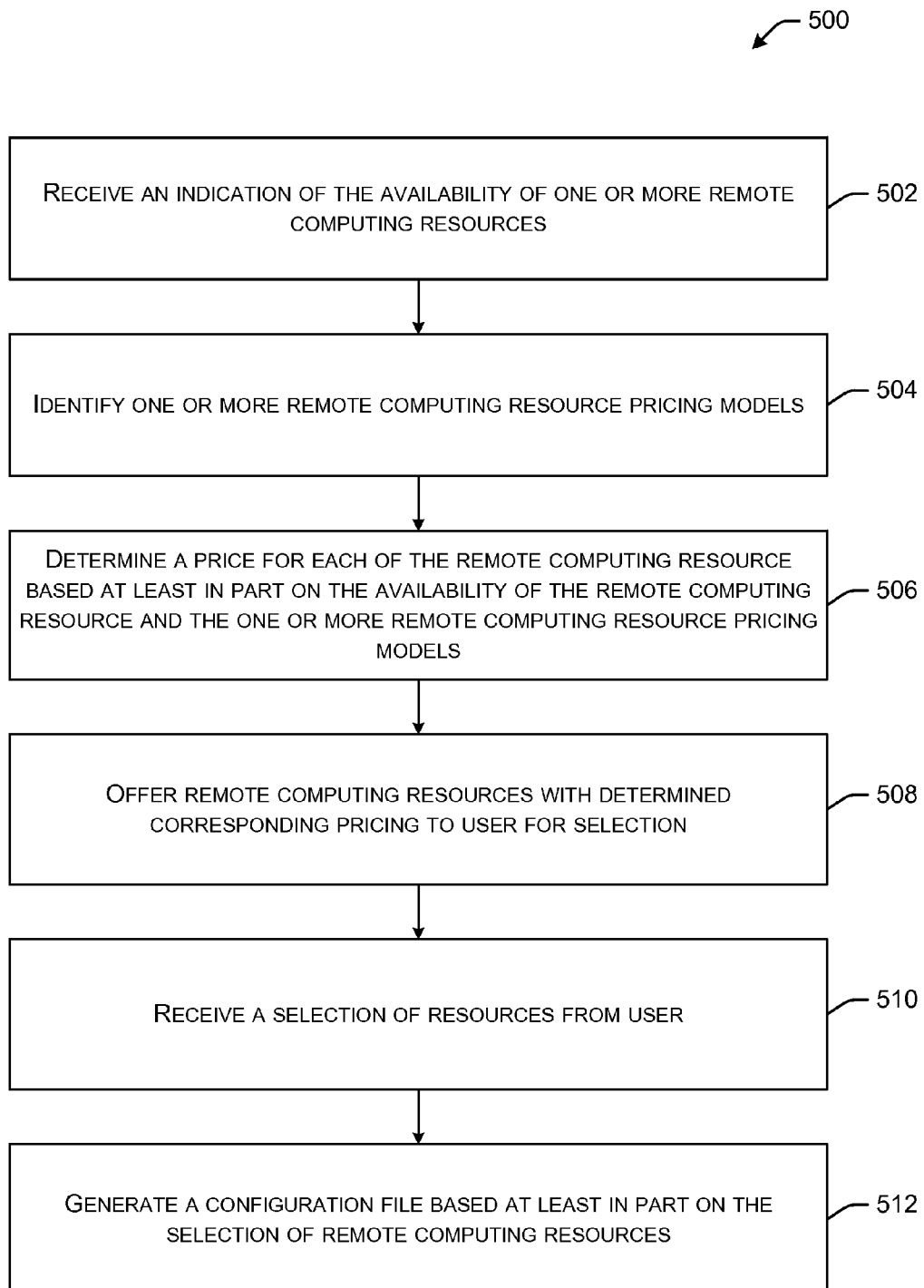


FIG. 5

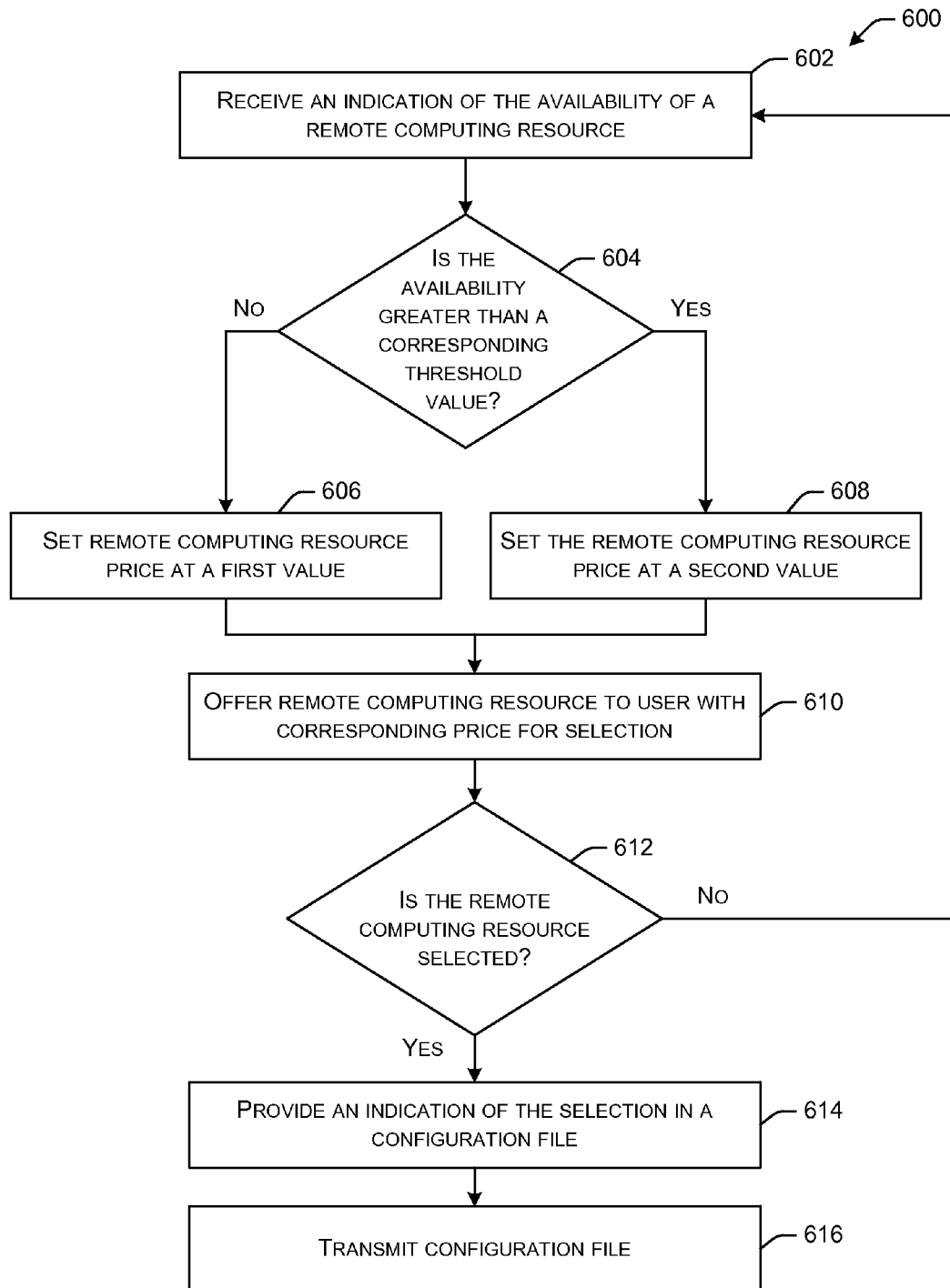


FIG. 6

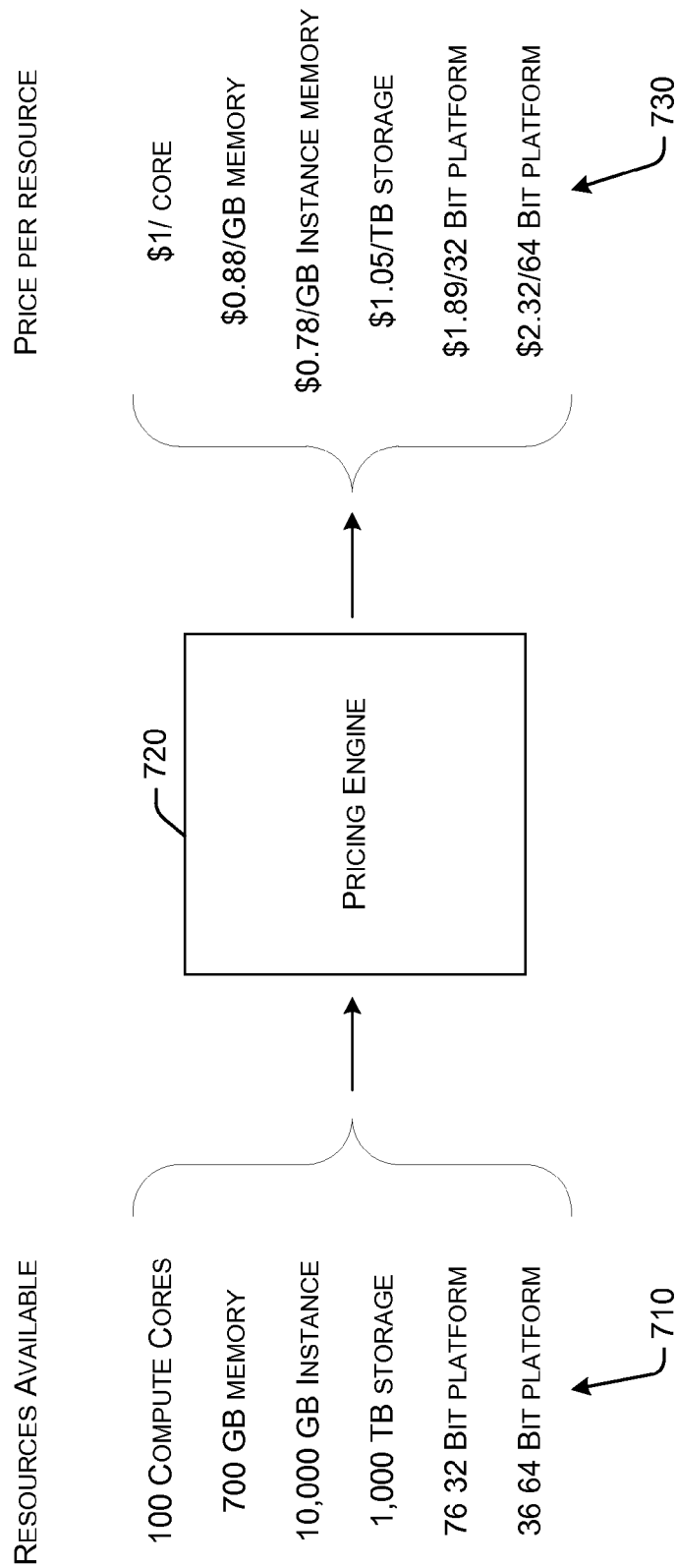


FIG. 7

804 PLEASE CONFIGURE YOUR INSTANCE 800

| 808 COMPUTATIONAL CORES | | 812 PRICE | 816 TOTAL PRICE |
|--|-----|-----------|-----------------|
| <input type="radio"/> 1 CORE | | \$1 | \$1 |
| <input type="radio"/> 2 CORES | | \$2 | \$2 |
| <input checked="" type="radio"/> 4 CORES | | \$4 | \$4 |
| <input type="radio"/> 8 CORES | 824 | \$8 | \$8 |
| 830 MEMORY | | | |
| 834 <input type="text" value="2"/> GB | | \$0.88/GB | \$1.76 |
| 840 PLATFORM | | | |
| <input type="radio"/> 32 BIT | | \$1.89 | \$1.89 |
| <input type="radio"/> 64 BIT | | \$2.32 | \$2.32 |

FIG. 8

CONFIGURABLE VIRTUAL MACHINES**BACKGROUND**

With increasing availability of inexpensive communications bandwidth, remote computing or cloud computing, where processing and storage resources may be located remotely from the point of usage of the processing and storage resources, has become more widely available. Third party entities may offer these remote computing resources to organizations and individual users remotely from the organizations and users. Remote computing methods may, therefore, enable an organization to outsource its information technology needs to an outside vendor and allow the outside vendor to provide processing and storage resources, as well as information security, scalability, reliability, and the like.

The third party providers of the remote computing resources may, in turn, make relatively effective use of computing resources by centralizing the resources and providing computing resources to multiple organizations and users. In so doing, remote computing providers may have a plurality of computers or servers, a plurality of storage devices, and a variety of other computing resources to meet the computing and storage needs of the multiple organizations and/or individuals for whom the remote computing providers provide service.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description is set forth with reference to the accompanying figures. The use of the same reference numbers in different figures indicates similar or identical items; however, various embodiments may utilize elements and/or components other than those illustrated in the figures.

FIGS. 1A and 1B are schematic diagrams that illustrate an example architecture for providing remote computing services, in accordance with embodiments of the disclosure.

FIG. 2 is a schematic diagram that illustrates an example resource center for providing remote computing services to a user, in accordance with embodiments of the disclosure.

FIG. 3 is a flow diagram illustrating an example method for providing a virtual machine configuration file, in accordance with embodiments of the disclosure.

FIG. 4 is a flow diagram illustrating an example method for providing the virtual machine to a user, in accordance with embodiments of the disclosure.

FIG. 5 is a flow diagram illustrating an example method to generate a configuration file based at least in part on providing resource pricing and receiving a selection of resources, in accordance with embodiments of the disclosure.

FIG. 6 is a flow diagram illustrating an example method for selecting between two different prices for a resource and providing a configuration file based on a user selection of the resource, in accordance with embodiments of the disclosure.

FIG. 7 is a diagram illustrating an example pricing engine for a variety of remote computing resources, in accordance with embodiments of the disclosure.

FIG. 8 is a schematic diagram illustrating an example user interface for selecting remote computing resources to customize a virtual machine, in accordance with embodiments of the disclosure.

DETAILED DESCRIPTION**Overview**

Embodiments of the present disclosure are directed to, among other things, providing remote computing resources,

such as cloud computing services, in a dynamic and customizable fashion. In one aspect, remote computing services may be offered to users of the remote computing resources via communicative connections such as the Internet. In certain aspects, a particular user may be able to select computing resources that may be used in providing the remote computing services offered to the user. Therefore, an entity providing remote computing services, such as a remote computing service provider, may be configured to provide remote computing services to the user based on computing resources selected by the user. The remote computing service computer may provide the user with a virtual machine that uses the resources that have been selected by the user. Indeed, the user may be able to select computing resources prior to receiving and/or utilizing the remote computing services. Additionally, the user may be able to select additional computing resources after already using the remote computing service. In other words, the user may be able to modify the remote computing resources that are used to provide the user with remote computing services. The user may therefore customize his/her virtual machine, also known as an instance, prior to launch or after launch.

In the context of this disclosure, the user may be any suitable entity that may acquire and/or use remote computing services, including individuals, organizations, corporations, non-profit organizations, or the like. The remote computing resources may be any suitable computing resources, including processing resources, such as central processing units and/or graphics processing units, memory resources, such as dynamic random access memory (DRAM), storage resources, such as solid state disk drives (SSDs), hard disk drives (HDD), or networking devices. The remote computing resources, in certain embodiments, may be operated at geographic locations that are remote or otherwise accessible via a network by the user. The virtual machine, or instance, may appear to the user as a server providing computing services that the user may be able to access using a user device. The virtual machine may provide the user the look and/or feel of a local computing machine. Therefore, the virtual machine may be seamlessly provided to the user by the remote computing service provider in a manner that appears to the user as if he/she/they are operating and/or using a local computing machine. For example, the user may be able to “log-in” to the virtual machine using the user device to execute computing tasks, such as word processing or spreadsheet tasks.

The remote computing service provider that provides the remote computing services in the form of providing virtual machines to multiple users may have one or more service centers that house the various remote computing resources that may be selected and mixed and matched by a user to provide virtual machines to various users. These service centers, in some cases, may be geographically separated from each other. These computing resource centers may have one or more remote computing servers that may provide the various virtual machines to the corresponding respective users. The remote computing servers may receive a configuration file, or other indication of a configuration, for configuring a virtual machine for a particular user. The configuration file may include various elements associated with the remote computing resources that may be used to provide the virtual machine. These various elements of the configuration file may include an indication of remote computing resources that may be allocated to provide the requested virtual machine. Therefore, the remote computing servers may “build” a virtual machine by accessing and/or using remote computing resources indicated on the configuration files. In certain

embodiments, particular remote computing resources may be uniquely allocated to a particular virtual machine.

The configuration file may be generated by one or more configuration servers. These configuration servers may be configured to generate and/or receive an inventory of resources that may be available at various resource centers of the remote computing service provider. The configuration servers may further be configured to provide to existing users and/or new users an indication of remote computing resources that are available at the various resource centers. The configuration servers may further be configured to interact with a user, or an agent thereof, such as a system administrator associated with the user, that may select one or more remote computing resources to configure his/her/their virtual machine. The interaction may be enabled by the user being presented a selection of remote computing resources available for configuring their virtual machine. The interaction may be conducted, in these embodiments, via a communications network or other suitable communicative link as well as the user's user device. Therefore, the configuration file may be generated based at least in part on received user input indicative of a selection of remote computing resources.

In certain embodiments, the indication of remote computing resources available and presented to a user by the configuration servers may be based at least in part on the inventory of remote computing resources as identified by the configuration server. Therefore, in certain embodiments, the remote computing resources selected by a user for "building" a virtual machine may be based at least in part on an assessment of which resources are available and not being used in providing virtual machines to other users. Once the configuration server receives an indication of remote computing resources requested by the user, the configuration server may generate an indication of the requested remote computing resources, such as in the form of the configuration file. In these and other embodiments, the server may further update the inventory of remote computing resources when a particular user relinquishes the use of one or more remote computing resources. For example, if a particular user no longer needs a virtual machine provided to that user, the configuration servers may indicate the resources associated with that virtual machine as being available again. Therefore, it will be appreciated that in certain embodiments, the configuration servers may update one or more inventories of remote computing resources based at least in part on one or more of deployment of remote computing resources, return of remote computing resources, or addition or removal of remote computing resources for the purposes of offering remote computing services by the provider of remote computing resources.

In certain embodiments, the configuration servers may be configured to provide pricing information to remote computing resources based at least in part on their availability. Indeed, these embodiments may allow or differential pricing of remote computing resources based upon current availability and/or utilization of a variety of classes of remote computing resources. In certain cases, a particular remote computing resource that has a relatively high level of availability may be priced at a level less than a level of pricing had that remote computing resource had a relatively lower availability. For example, HDD storage may be priced at \$0.25/terabyte (Tb)/month if the remote computing service provider has 1024 Tb of storage available, but may be priced at \$0.30/Tb/month if the remote computing service provider has 256 Tb or less of storage available.

The configuration servers, therefore, may have a variety of pricing models and/or algorithms that may be used to determine pricing of remote computing resources. The configura-

tion servers may execute these models and/or algorithms on one or more processors of the configuration servers. The pricing ascertained from the pricing models may be used to update a price list associated with presenting users with user interfaces (UI) with remote computing resource availability. In other words, remote computing resources that may be selected by the user to configure a virtual machine may present pricing of individual remote computing resources, so that the user may decide which resource to pick based at least in part on the pricing of the resources and/or pricing of a fully configured virtual machine.

In certain embodiments, the configuration servers may provide the pricing of the remote computing resources for a limited period of time. In other words, when the pricing of the various available remote computing resources are presented to a user for selection, those prices may be available for a predetermined period of time. Therefore, a user may need to make a selection of the resources at the corresponding respective prices before the prices expire to not risk being offered new and/or updated prices corresponding to the offered remote computing resources. In some cases, the user may be presented, such as on the UI, with a time, a timer, and/or an indication of the time for which the prices presented to the user may be in effect. Based on this "freshness time" the user, in some cases, may be able to determine how long the user will take to decide which remote computing resources are to be selected.

The configuration servers, in certain embodiments, may provide an availability and/or corresponding pricing of remote computing resources based on an application basis and/or a limited time basis. In other words, a user may need an increase or decrease in remote computing resources for its corresponding virtual machine for a predetermined period of time and may request changes to the configuration of their virtual machine only during that predetermined period of time. As an example, consider a tax accounting firm that may need additional remote computing resources for a period of two months preceding the time when federal income taxes are due. In these cases, the configuration servers may be configured to provide remote computing resources to a particular user for a predetermined period of time as an application and/or project basis. In certain embodiments, the configuration servers may be configured to provide a pricing for remote computing resources based at least in part on information related to the time period for which the resources may be deployed.

The configuration servers may, in certain embodiments, present a preconfigured template of a virtual machine that may further be configured by a user to build his/her/their virtual machine. In other words, the configuration servers may present a virtual machine with preselected remote computing resources. The configuration servers may further be able to accept changes to the preselected remote computing resources. These changes may be made by the user to customize the virtual machine resulting from the selected remote computing resources. In these embodiments, the configuration servers may further determine pricing of a variety of remote computing resources. This pricing may be determined based at least in part on the availability and/or utilization of various classes of remote computing resources. The pricing information may be presented to the user while the user is making selections of remote computing resources. Therefore, the user interface for making the selections of the remote computing resources may present the pricing of each of the remote computing resources so that the user can see what the cost may be as he/she/they make their selections and/or modifications.

This brief introduction, including section titles and corresponding summaries, is provided for the reader's convenience and is not intended to limit the scope of the claims, nor the preceding sections. Furthermore, the techniques described above and below may be implemented in a number of ways and in a number of contexts. Several example implementations and contexts are provided with reference to the following figures, as described below in more detail. However, the following implementations and contexts are but a few of many.

Illustrative Architecture

FIGS. 1A and 1B depict an example architecture 100 in which techniques for providing remote computing services may be implemented in accordance with embodiments of the disclosure. In architecture 100, one or more remote computing service providers 110 may be configured to provide remote computing services via one or more networks 120 by providing one or more virtual machines 124(1)-(N), also referred to as instances and collectively or individually referred to as virtual machine 124, that may be accessed by one or more user devices 128(1)-(N), collectively or individually referred to as user device 128, by users 132(1)-(N), collectively or individually referred to as 132. Although a single respective user device 128 and a single respective user 132 is depicted as accessing each virtual machine 124, it will be appreciated that there may be any number of individuals and/or users 132 accessing each of the virtual machines 124 via any number of user devices 128.

The users 132, as used herein, may refer to either an organization or an individual. The organization may be a company, non-profit organization, for-profit organization, a religious organization, a community organization, a government agency, or the like. Therefore, each organization may have multiple individuals. Indeed, multiple individuals from an organization may be able to access a virtual machine 124 associated with that organization. For example, a company may purchase remote computing services from a remote computing service provider 110 and employees of that company may be able to access the virtual machine 124 provided to the company using respective user devices 128.

The user devices 128 may be any variety of computing devices including, but not limited to, servers, desktop computers, notebook computers, netbook computers, tablet computing devices, pad computing devices, personal digital assistants (PDAs), smart phones, digital readers, or combinations thereof. In some cases, the user devices 128 may be "intelligent devices" that may execute one or more programs and user applications locally on processor(s) (not shown) of the user devices 128. In other cases, the user devices 128 may be "dumb terminals" configured to primarily execute software, programs, or user applications related to serving, displaying, or otherwise rendering information or content provided from sources external to the user devices 128, such as rendering displays associated with the corresponding virtual machine 124 provided by the remote computing service provider 110. Indeed, the architecture 100 may include both "intelligent devices" and "dumb terminals." Furthermore, the architecture 100 may include a variety of user device types. For example, there may be multiple users 132 each accessing the remote computing servers 150 via different types of user devices 128.

The remote computing service provider 110 may include one or more remote computing resource centers 140(1)-(N), collectively or individually referred to as remote computing resource centers 140, and may house one or more remote computing resources, such as one or more remote computing servers 150, one or more memory devices 152, one or more

configuration servers 154, one or more storage devices 156, or the like. The remote computing resource centers 140 may be geographically separated from each other in certain embodiments. In other embodiments, the remote computing resource centers 140 may be relatively proximal to each other.

In certain embodiments, the individual remote computing resource centers 140, and remote computing resources 150, 152, 154, 156 therein, may be configured to provide particular virtual machines 124. In other words, a particular virtual machine 124 may be served from a single remote computing service center 140. In other embodiments, a virtual machine 124 may be provided from more than one remote computing service center 140, using remote computing resources 150, 152, 154, 156 located at the various remote computing resource centers 140.

Although a single remote computing server 150, memory device 152, configuration server 154, and storage device 156 is depicted at each of the remote computing resource centers 140, it will be appreciated that there may be any number and/or amount of these resources 150, 152, 154, 156 at each of the remote computing resource centers 140. In addition, there may be a variety of each of these resources with a variety of processing capabilities, bandwidth, bus size, latency, manufacturers, or the like. It will be appreciated that there may be a variety of remote computing resources, including ones that have not been depicted herein. These remote computing resources may include, but are not limited to processing cores, graphics processors/cores, 32-bit systems, 64-bit systems, solid state drives (SSD), magnetic and/or optical hard disk drives (HDD), tape drives, compact disk (CD) drives, digital video disk (DVD) drives, volatile memory, non-volatile memory, or the like.

In one aspect, the remote computing servers 150 may be configured to execute and provide virtual machine instances 124. Each remote computing server 150 may be configured to provide either single or multiple virtual machines 124. The remote computing servers 150 may be any suitable server for configuring, managing, and/or providing remote computing services in the form of virtual machines 124 to one or more users 132. For example, the remote computing servers 150 may be rack mounted servers, blade servers, or any other suitable computing configuration.

The remote computing servers 150 may be configured to receive a configuration file or other indication of a virtual machine configuration and based at least in part on the configuration file, deploy remote computing resources 150, 152, 154, 156, to provide the user 132 with a virtual machine 124. In one aspect, the received configuration file may be indicative of a virtual machine configuration selected by the user 132. The configuration file may be received in the form of one or more data packets by the remote computing servers 150 from the configuration servers 154.

In effect, multiple virtual machine instances 124 may be allocated from a single remote computing server 150 or group of remote computing servers 150. Therefore, when computing resources 150, 152, 154, 156 are provided to a user 132, a new virtual machine instance 124 may be launched on the remote computing servers 150. When a user 132 returns the computing resources 150, 152, 154, 156, or otherwise ceases to receive the remote computing services from the remote computing service provider 110, the instance 124 associated therewith may be terminated.

Memory devices 152 as used herein may include any variety of electronic storage. The memory devices 152 may store program instructions that are loadable and executable on the processor(s) associated with the remote computing servers 150, as well as data generated during the execution of these

programs. Depending on the configuration and type of remote computing servers **150**, the memory devices **152** may be volatile (such as random access memory (RAM)) and/or non-volatile (such as read-only memory (ROM), flash memory, etc.). In some implementations, the memory devices **152** may include multiple different types of memory, such as static random access memory (SRAM), dynamic random access memory (DRAM), and/or ROM. Although depicted at a location outside of the remote computing servers **150**, it will be appreciated that in certain embodiments, the memory devices may be located within a housing of one or more of the remote computing servers **150**.

The configuration servers **154**, may be similar to the remote computing servers **150** in that the configuration servers may be any suitable type of server, such as a blade server or a rack mounted server. Although the architecture **110** is depicted having a single configuration server **154** at each of the remote computing resource centers **140**, there may be more than one, one or no configuration server at a particular remote computing resource center **140**. In certain cases, a single configuration server **154** may provide virtual machine configuration services to multiple remote computing resource centers **140** and multiple associated remote computing servers **150**.

The configuration servers **154** may be configured to identify the availability and/or the utilization of various remote computing resources. The configuration servers **154** may further be configured to provide an indication available remote computing resources to users of remote computing services. The configuration servers **154** may still further be configured to solicit configuration requests from a user **132** requesting and/or modifying remote computing services. For example, the configuration servers **154** may be able to render a user interface on the user device **128** associated with the user **132** to solicit user input related to virtual machine configurations. Further yet, the configuration servers **154** may be configured to generate a configuration file, or other indication of a requested configuration, based on a selection of resources that may be used to build a virtual machine. The configuration servers **154** may provide the configuration file to one or more remote computing servers **150** to allocate remote computing resources **150**, **152**, **154**, **156** corresponding to the configuration file.

In certain embodiments, the configuration servers **154** may be configured to identify one or more pricing models and/or algorithms that may provide pricing of various remote computing resources **150**, **152**, **154**, and **156**, based at least in part on the availability and/or utilization of the remote computing resources **150**, **152**, **154**, and **156**. Therefore, the configuration servers **154** may generate a price list for various remote computing resources. In certain embodiments, this price list may be updated by the configuration servers **154** when there is a change in the deployment of remote computing resources **150**, **152**, **154**, **156**. In other embodiments, the price list may be modified at predetermined times and/or on a periodic basis by considering a new inventory of available and/or deployed remote computing resources **150**, **152**, **154**, **156** by the configuration servers **154**.

The configuration servers **154** may further be configured to present the pricing of one or more remote computing resources **150**, **152**, **154**, **156** to the user **132** when soliciting remote computing resource selections from the user **132** for the purpose of configuring the user's virtual machine **124**. Therefore, in one aspect, the user may select between and among various remote computing resources **150**, **152**, **154**, **156** based at least in part on the corresponding respective pricing of the various remote computing resources **150**, **152**,

154, **156**. In some cases the models used to price the one or more remote computing resources **150**, **152**, **154**, **156** may be based at least in part on predictions of the price elasticity of the various remote computing resources and/or predictions of a user's propensity to select a particular remote computing resource **150**, **152**, **154**, **156** at various price points.

Storage capacity **156**, as used herein, may refer to any form of electronic storage that may be used and/or may be available to a particular user **132** to store electronic information or data. The information or data may be in any form of analog or digital data. In certain embodiments, digital data storage capacity may be offered by the provider of remote computing service provider **110**. Electronic information or data stored on the storage capacity **156** may include, but is not limited to, computer files, documents, audio files, video files, other media files, computer programs, applications, scripts, files containing proprietary, confidential, personal, or sensitive information, or combinations thereof.

It will further be appreciated that the storage capacity **156** provided to a particular user **132** may include one storage device, portions of a storage device, more than one storage device, or more than one portion of the storage devices. For example, if a particular user requires 10 terabytes (Tb) of storage capacity, then the provider of the remote computing resources may allocate five 2 Tb hard disk drives (HDDs) to provide the full 10 Tb requirement. Alternatively, the 10 Tb capacity may be provided using three 3 Tb HDDs and 1 Tb of a 3 Tb HDD. The storage devices **156**, or portions thereof, that provide the storage capacity to the user **132** of the remote computing services may be of any suitable type of data storage or mass storage device with any suitable storage capacity. The storage devices may be, for example, any combinations of HDDs of any format and interface(s), optical storage drives, opto-magnetic storage drives, compact disc (CD) drives, digital video disc (DVD) drives, solid state drives (SSD), flash memory drives, or the like.

The memory devices **152** and/or the storage devices **156**, both removable and non-removable, are all examples of computer-readable storage media. For example, computer-readable storage media may include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules, and/or other data.

The networks **120** may include any one or a combination of different types of suitable communications networks, such as cable networks, the Internet, wireless networks, cellular networks, and other private and/or public networks. Furthermore, the networks **120** may include any variety of medium over which network traffic is carried including, but not limited to, coaxial cable, twisted wire pair, optical fiber, hybrid fiber coaxial (HFC), microwave terrestrial transceivers, radio frequency communications, satellite communications, or combinations thereof. While the illustrated example represents the users **102** accessing the remote computing servers **150** over the networks **120** using the user device **128**, it will be appreciated that the users **132** may access one or more other elements via the network **120**. It is also noted that the described techniques may apply in other client/server arrangements (e.g., set-top boxes, etc.), as well as in non-client/server arrangements (e.g., locally stored software applications, etc.).

Referring now to FIG. 2, an illustration of an example resource center **140** for providing remote computing services to the user **132**, in accordance with embodiments of the disclosure is described. The remote computing servers **150** may include one or more processors **180**, one or more graphics

processing units (GPU) **182**, one or more input output (I/O) interfaces **184**, one or more communications interfaces **186**, and one or more memories **190**. It will be appreciated that the remote computing servers **150** may include other components or elements that enable the remote computing servers **150** to perform the methods and processes described herein in accordance with embodiments of the disclosure.

The one or more processors **180** may be configured to execute and/or operate one or more instructions, applications, and/or software stored in the memory **190** of the remote computing servers **150** to provide remote computing services. The processors **180** may further be configured to receive input from or provide output to user interfaces of the remote computing servers **150**.

In some examples, the one or more processors **180** of the remote computing servers **150** may be implemented as appropriate in hardware, software, firmware, or combinations thereof. Software or firmware implementations of the one or more processors **180** may include computer-executable or machine-executable instructions written in any suitable programming language to perform the various functions described. Hardware implementations of the processors **180** may be configured to execute computer-executable or machine-executable instructions to perform the various functions described. The one or more processors **180** may include, without limitation, a central processing unit (CPU), a digital signal processor (DSP), a reduced instruction set computer (RISC), a complex instruction set computer (CISC), a microprocessor, a microcontroller, a field programmable gate array (FPGA), or any combination thereof. The remote computing server **150** may also include a chipset (not shown) for controlling communications between the one or more processors **180** and one or more of the other components of the remote computing server **150**. The one or more processors **180** may also include one or more application specific integrated circuits (ASICs) or application specific standard products (ASSPs) for handling specific data processing functions or tasks.

The GPU **182** may include any suitable electronic hardware, software, or combination thereof that performs a rendering and/or acceleration of graphics functions of the remote computing server **150**. In one aspect, the GPU **182** may provide graphical functions locally at the remote computing server **150**. In other cases, the GPU **182** may provide graphical functions to the virtual machines **124** provided by the remote computing servers **150**. The I/O interfaces(s) **184**, may include any suitable interface configured to interface between the processors **180** and the components of the remote computing servers **150** and/or a variety of remote computing resources, such as the remote computing servers **150**, the memory devices **152**, the configuration servers **154**, the storage devices **156**, or one or more networking devices at the remote computing resource center **140**. I/O device(s) may include any variety of suitable devices including a keyboard, a mouse, a pen, a voice input device, a touch input device, a display, speakers, a printer, etc. The communications interfaces(s) **186** may allow the remote computing servers **150** to communicate with stored databases, other computing devices or servers, user terminals, and/or other devices on the networks **120** to the user devices **132** or local area networks (LAN) **200** at the remote computing resource center **140**.

The memory **190** may include one or more volatile and/or non-volatile memory devices including, but not limited to, random access memory (RAM), dynamic RAM (DRAM), static RAM (SRAM), synchronous dynamic RAM (SDRAM), double data rate (DDR) SDRAM (DDR-SDRAM), RAM-BUS DRAM (RDRAM), flash memory devices, electrically erasable programmable read only

memory (EEPROM), non-volatile RAM (NVRAM), universal serial bus (USB) removable memory, or combinations thereof. The memory **190** may be a segment and/or partition of the memory **152**. In other words, memory allocated to enable the functionality of the remote computing servers **150** and memory allocated to the virtual machines **124** may be partitions from the same memory devices **152**. The memory **190** may store program instructions that are loadable and executable on the processor(s) **180**, as well as data generated or received during the execution of these programs.

Turning to the contents of the memory **180** in more detail, the memory **180** may include an operating system (O/S) **192**, applications **194**, a virtual machine module **196**, and/or a user interaction module **198**. Each of the modules and/or software may provide functionality for the remote computing server **150**, when executed by the processors **180**. The modules and/or the software may or may not correspond to physical locations and/or addresses in memory **190**. In other words, the contents of each of the modules may not be segregated from each other and may, in fact be stored in at least partially interleaved positions on the memory **190**.

The O/S **192** may have one or more operating systems stored thereon. The processors **180** may be configured to access and execute one or more of the O/S **192** to operate the system functions of the remote computing server **150**. System functions, as managed by the O/S **192** may include memory management, processor resource management, driver management, application software management, system configuration, and the like. The O/S may be any variety of suitable operating systems including, but not limited to, Google® Android®, Microsoft® Windows®, Microsoft® Windows® Server®, Linux, Apple® OS-X®, Apple® iOS®, or the like. The O/S **192** may further be utilized in the virtual machine **124** provided to the user via user devices **128** and network **120**. In other words, the O/S **192** may be the framework under which the user **132** may interact with the virtual machine and the remote computing servers **150** and the remote computing resources **150**, **152**, **154**, **156**, **158**.

The applications module **194** may have one or more software applications stored thereon that may be accessed and executed by the processors **180** to provide the remote computing server **150** functionality and services that may be accessed by the user **132** via a corresponding respective virtual machine **124**. The one or more applications **194** may be run on the remote computing server **150** to process files and data locally on the remote computing server **150** or remotely from the remote computing server **150**. The files and data may, in one aspect, be saved locally on the user device **128** or be transmitted to the remote computing servers **150** to be stored thereon, or both. As an example, consider that a user **132** opens and processes a spreadsheet file on the respective corresponding virtual machine **124**. The spreadsheet file may be opened locally on the user device **128** using a spreadsheet application corresponding to the spreadsheet file. After a user **132** manipulates the spreadsheet file on the user device **128**, the user **132** may choose to save the spreadsheet file locally on the user device **128**, send the file to the remote computing servers **150** for storage, or both save the file locally and remotely. In certain embodiments, the user **132** may access and use remote applications that may be run remotely from the user device **132**, such as at the remote computing servers **150** and presented to the user **132** within the virtual machine **124**. For example, a user **132** may open and manipulate a word processing file on the corresponding respective virtual machine **124**, and the word processing application program with which the user **132** interacts may be executed on the remote computing servers **150**. Therefore, the word process-

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ing file may be stored, accessed, and manipulated remotely from the user device 128. The user device 128 may have one or more running thereon that may render the operation of the word processing program on a user display or user interface of the user device 128. In one aspect, the applications 194 may be configured to receive data from the remote computing servers 150 via the network 120 and render the same to the user 132. The applications 194 may further receive user input on the user device 128 and convey the input to the remote computing servers 150 via the network 120. Other non-limiting interactions between the user device 128 and the remote computing servers 150 may include executing applications on the remote computing servers 150 and storing files and data on the user device 128, or storing the files or data at both the remote computing servers 150 and locally and executing the applications that use the files or data at the remote computing servers 150.

The virtual machine module 196 may have stored thereon instructions and/or applications that when executed by processors 180 may provide various functionality associated with providing a virtual machine 124 to a particular user 132. The instructions, when executed by the processors 180 may configure the remote computing server 150 to receive a configuration file from other entities of architecture 100, such as the configuration server 154 via LAN 200 or other suitable communicative connections. The remote computing server 150 may further be configured to configure a virtual machine 124 based at least in part on the received configuration file by allocating one or more remote computing resources 150, 152, 154, 156, 158. The remote computing server 150, therefore, may provide the virtual machine and the functionality and/or service associated therewith to the user 132 via network 120 and user device 128. In certain embodiments, the configuration file received by the remote computing servers 150 may be indicative of remote computing resources 150, 152, 154, 156, 158 selected by the user 132 for configuring the user's virtual machine 124. In some cases, the user 132 may be presented with pricing, such as real time pricing, of various remote computing resources 150, 152, 154, 156, 158 that may be selected for configuring their virtual machine 124 in generating the configuration file that is used by the remote computing server 150 for configuring the virtual machine 124.

The user interaction module 198 may have stored thereon instructions and/or applications that when executed by processors 180 may provide various functionality associated with providing remote computing services to the user 132. In one aspect, the processors 180 may be configured to launch or close applications of the application module 194 based at least in part on user 132 interaction with the respective virtual machine 124. The processors 180 may also be configured to engage the user 132 with the configuration server 154 if the user 132 wishes to modify aspects of and/or reconfigure his/her/their virtual machine 124.

It will be appreciated that there may be overlap in the functionality of the instructions stored in the O/S module 192, applications module 194, virtual machine module 196, and the user interaction module 198. In fact, the functions of the three aforementioned modules 192, 194, 196, 198 may interact and cooperate seamlessly under the framework of the remote computing servers 150. Indeed, each of the functions described for any of the modules 192, 194, 196, 198 may be stored in any other module 192, 194, 196, 198 in accordance with certain embodiments of the disclosure. Further, in certain embodiments, there may be one single module that includes the instructions, programs, and/or applications

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described within the O/S module 192, applications module 194, virtual machine module 196, and the user interaction module 198.

The configuration servers 154 may include one or more processors 160 one or more input output (I/O) interfaces 162, one or more communications interfaces 164, and one or more memories 170. It will be appreciated that the configuration servers 154 may include other components or elements that enable the configuration servers 154 to perform the methods and processes described herein in accordance with embodiments of the disclosure. The one or more processors 160 one or more input output (I/O) interfaces 162, one or more communications interfaces 164, and one or more memories 170 are substantially similar to the one or more processors 180 one or more input output (I/O) interfaces 184, one or more communications interfaces 186, and one or more memories 190, respectively, of the remote computing servers 150. Therefore, in the interest of brevity, the description of these elements will not be repeated here.

Turning to the contents of the memory 170 in more detail, the memory 170 may include an operating system (O/S) 172, applications 174, a configuration module 176, and/or a resource management and pricing module 198. Each of the modules and/or software may provide functionality for the configuration server 154, when executed by the processors 160. The modules and/or the software may or may not correspond to physical locations and/or addresses in memory 170. In other words, the contents of each of the modules may not be segregated from each other and may, in fact be stored in at least partially interleaved positions on the memory 170.

The remote computing servers 140 may further include one or more memories 170, herein referred to as memory 170. The memory 170 may store program instructions that are loadable and executable on the processor(s) 144, as well as data generated during the execution of these programs. Depending on the configuration and type of remote computing servers 140, the memory 170 may be volatile (such as random access memory (RAM)) and/or non-volatile (such as read-only memory (ROM), flash memory, etc.). In some implementations, the memory 170 may include multiple different types of memory, such as static random access memory (SRAM), dynamic random access memory (DRAM), and/or ROM.

The memory 170 and/or the storage devices 160, both removable and non-removable, are all examples of computer-readable storage media. For example, computer-readable storage media may include volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage of information such as computer-readable instructions, data structures, program modules, and/or other data.

Turning to the contents of the memory 170 in more detail, the memory 170 may include an operating system (O/S) module 172, one or more application programs 174, a configuration module 176, and a resource management and pricing module 178. Each of the modules and/or software may provide functionality for the configuration servers 154, when executed by the processors 160. The modules and/or the software may or may not correspond to physical locations and/or addresses in memory 170. In other words, the contents of each of the modules may not be segregated from each other and may, in fact be stored in at least partially interleaved positions on the memory 170. The O/S module 172 and the applications module 174 may be substantially similar to the O/S module 192 and the applications module 194, respectively, and, therefore, the description of these modules 172, 174 will not be repeated here.

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The configuration module 176 may have stored thereon instructions and/or applications that when executed by processors 160 may provide various functionality associated with configuring a virtual machine 124, such as by deploying underlying remote computing resources 150, 152, 154, 156, 158 with the virtual machine 124. In certain aspects, the processors 160 may be configured to determine the remote computing resources 150, 152, 154, 156, 158 that are currently available and/or currently deployed to other virtual machines 124. In other words, the processors 160 may be configured to assess the utilization status and, in some cases, create an inventory of the variety of remote computing resources 150, 152, 154, 156, 158 at the remote computing resource center 140 along with utilization status. In certain embodiments, the processors 160 are configured to generate an inventory of available remote computing resources 150, 152, 154, 156, 158 dynamically based at least in part on updated information related to deployments and/or release of virtual machines 124 and/or addition of new or removal of old remote computing resources 150, 152, 154, 156, 158 to the remote computing service provider 110. Therefore in some cases, when a new virtual machine 124 is deployed, returned or reconfigured, the configuration server 154 may generate a new inventory of remote computing resources 150, 152, 154, 156, 158 upon the indication of the changes to one or more virtual machine 124 configurations.

The processors 160, by executing instructions stored in the configuration module 176, may further be configured to provide a display of the available remote computing resources 150, 152, 154, 156, 158 to the user 132 for initial configuration and/or subsequent modification of the configuration of the user's virtual machine 124. The configuration server 154 may further be configured to receive user 132 indications of remote computing resources 150, 152, 154, 156, 158 to associate with the user's virtual machine 124. This input may be received via the user device 128 and the networks 120 as the user 132 interacts with a user interface provided by the configuration server 154, the user device 128, or the combination thereof.

Further still, the processors 160, by executing instructions stored in the configuration module 176, may be configured to generate a configuration file that may be transmitted by the configuration server 154 to the remote computing server 150 via the networks 200 or other suitable communicative links. The configuration file may be indicative of user selections of remote computing resources 150, 152, 154, 156, 158 for configuring the user's virtual machine 124. The configuration file may provide information, in one aspect, to the remote computing servers 150 for deploying particular remote computing resources 150, 152, 154, 156, 158 for the purpose of providing the user's virtual machine 124. The remote computing resources 150, 152, 154, 156, 158 that are identified on the configuration file may be identifier by any variety of suitable identifiers including, but not limited to, resource type, resource location, resource, identification number and/or code, resource manufacturer, resource capacity, resource performance capacity, or combinations thereof. In certain embodiments, the remote computing resources 150, 152, 154, 156, 158 selected for building a new virtual machine 124 or reconfiguring an existing virtual machine 124 may be identified by a unique identifying number and/or code. This unique identifying number and/or code may be provided in the configuration file that the configuration server 154 based on user 132 input. It will be appreciated that in certain embodiments, the configuration server 154 may use one or more mechanisms other than a configuration file to indicate to the remote

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computing server 150 remote computing resources 150, 152, 154, 156, 158 to be associated with a particular virtual machine 124.

The resource management and pricing module 178 may have instructions stored thereon that may be executed by the processors 160 to provide pricing information associated with available remote computing resources 150, 152, 154, 156, 158. Indeed the resource management and pricing module 178 may include pricing models and/or algorithms, such as regression models and the like. These models and/or algorithms may be performed by the processor 160 using remote computing resource 150, 152, 154, 156, 158 availability information to generate price lists of the available remote computing resources 150, 152, 154, 156, 158. The pricing information associated with non-deployed remote computing resources 150, 152, 154, 156, 158 may be presented to the user 132 when the user 132 configures the corresponding virtual machine 124.

In certain embodiments, when the processors 160 determine a price associated with available remote computing resources 150, 152, 154, 156, 158, the price may come with an associated effective time period. This time period may be the length of time over which the generated prices may be in effect. After that time period the prices may be subject to change based at least in part on new levels of available remote computing resources 150, 152, 154, 156, 158. In these and other embodiments, the user may be given a listing of available remote computing resources 150, 152, 154, 156, 158 and corresponding respective prices where the prices are in effect for the stipulated time period. In other words, the user 132 may have to select and configure the virtual machine before the pricing offered for the remote computing resources 150, 152, 154, 156, 158 expire.

In yet other embodiments, the configuration servers 154 may be configured to offer remote computing resource 150, 152, 154, 156, 158 prices on a per project and/or limited time deployment basis. In other words, a user 132 may choose to change an associated virtual machine 124 configuration for a limited period of time. For these types of changes to the virtual machine 124 configurations and associated deployment of remote computing resources 150, 152, 154, 156, 158, the user may be provided with different pricing for the remote computer resources 150, 152, 154, 156, 158, in some cases, than if a long term deployment is envisioned.

It will be appreciated that there may be overlap in the functionality of the instructions stored in the O/S module 172, applications module 174, configuration module 176, and the resource management and pricing module 178. In fact, the functions of the three aforementioned modules 172, 174, 176, 178 may interact and cooperate seamlessly under the framework of the configuration servers 154. Indeed, each of the functions described for any of the modules 172, 174, 176, 178 may be stored in any other module 172, 174, 176, 178 in accordance with certain embodiments of the disclosure. Further, in certain embodiments, there may be one single module that includes the instructions, programs, and/or applications described within the O/S module 172, applications module 174, virtual machine module 176, and the user interaction module 178.

60 Illustrative Processes

Referring now to FIG. 3, example method for providing a virtual machine configuration file, in accordance with embodiments of the disclosure is described. This method 200 may be implemented by the configuration servers 154. At block 302, available resources may be identified. These remote computing resources 150, 152, 154, 156 may be identified as deployed or available. In certain embodiments, a

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number of the total remote computing resources **150**, **152**, **154**, **156**, **158** of a particular type may be tallied. The information pertaining to the availability of the remote computing resources **150**, **152**, **154**, **156**, **158** may be stored and/or updated in the memory **170** of the configuration servers **154**.

At block **304**, pricing information may be generated based at least in part on the availability of the remote computing resources. In certain embodiments, algorithms and/or pricing models may be identified by the processors **160** to execute this process. These models and/or algorithms may be any variety of suitable pricing models including, but not limited to, regression models, machine learning models, look-up tables, or the like. These models and/or algorithms may, in certain embodiments, consider the availability of resources along with the utilization and/or deployment of the resources for providing remote computing services. The models and/or algorithms may be stored in and accessed from the memory **160** of the configuration servers **154**. In certain embodiments, the processors **160** and/or other entities may develop revisions to the pricing models and/or pricing algorithms based on a variety of metrics, such as user **132** price elasticity, cost of deployment, and/or lead time in the deployment of various remote computing resources **150**, **152**, **154**, **156**, **158**. In certain embodiments, the configuration servers **154** may maintain a price list of remote computing resources **150**, **152**, **154**, **156**, **158** and may update the price list on a periodic basis or when one or more changes to a virtual machine **124** is implemented, such as by deployment or release of remote computing resources **150**, **152**, **154**, **156**, **158**.

At block **306**, the user may be presented with choices of remote computing resources and pricing. In one aspect, information indicative of remote computing resource availability and associated pricing information may be transmitted via the networks **120** to user device **128** for presentation to the user **132**. The user may be able to view and interact with the availability and pricing information for the purposes of configuring their virtual machine. The information related to the available remote computing resources **150**, **152**, **154**, **156**, **158** and pricing may be transmitted in the form of one or more data packets to the user device **128**. In some cases, the information may first be transmitted to the remote computing servers **150** and/or other entities prior to transmission to the user device **128**. In some cases, the prices offered for the remote computing resources **150**, **152**, **154**, **156**, **158** may have a time period associated therewith during which the prices presented are valid. In other words, the prices offered may expire after some time and then new prices for the remote computing resources may be determined and offered to the user **132**.

At block **308**, an indication of remote computing resources requested by the user may be received. The indication may be in the form of one or more data packets received either directly or indirectly from the user device **128** associated with the user **132** that configures a respective corresponding virtual machine **124**. The indication may be indicative of a set or a portion of a set of remote computing resources **150**, **152**, **154**, **156**, **158** that may be used to configure a particular virtual machine **124**. In the cases where the pricing of the remote computing resources **150**, **152**, **154**, **156**, **158** come with an expiration time, the user **132** may be required to select the desired remote computing resources **150**, **152**, **154**, **156**, **158** within the allowed time period or risk a change in prices offered to the user **132**.

It should also be noted that in some cases, the pricing offered to the user **132** for remote computing resources **150**, **152**, **154**, **156**, **158** may be based at least in part on the period of time that the remote computing resources **150**, **152**, **154**,

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156, **158** may be deployed. For example, if the requested remote computing resources **150**, **152**, **154**, **156**, **158** are to be deployed for a limited period of time, such as for a special project, then the pricing of those remote computing resources **150**, **152**, **154**, **156**, **158** may be different than the pricing of remote computing resources **150**, **152**, **154**, **156**, **158** that may be deployed for relatively longer period of time.

At block **310**, a virtual machine configuration file may be provided based at least in part on the received indication of requested resources. In one aspect, the configuration file may be indicative of all or part of the remote computing resources **150**, **152**, **154**, **156**, **158** that may be used to configure a new virtual machine **124** or reconfigure a pre-existing virtual machine **124**. The configuration file may be transmitted by the configuration server **154** to the remote computing server **150** in the form of one or more data packets via the networks **200** or other suitable communicative links. In one aspect, the configuration file may indicate a list of remote computing resources **150**, **152**, **154**, **156**, **158** that may be deployed to build and/or provide the virtual machine **124** to the user **132**. Therefore, the configuration file may be received by the remote computing servers **150** and used to configure a virtual machine **124** by the remote computing server **150**.

It should be noted that the method **300** may be modified in various ways in accordance with certain embodiments. For example, one or more operations of the method **300** may be eliminated or executed out of order in other embodiments. Additionally, other operations may be added to the method **300** in accordance with other embodiments.

Referring now to FIG. 4, an example method **400** for providing the virtual machine to a user, in accordance with embodiments of the disclosure is described. The method **400** may be performed by the remote computing servers **150**. At block **402**, a configuration file indicative of a virtual machine configuration may be received. This configuration file may indicate remote computing resources that may be associated with a virtual machine **124** configuration. In other words, the configuration file may indicate using one or more identifiers, one or more virtual machine **124** configurations with associated remote computing resources **150**, **152**, **154**, **156**, **158** for the particular configuration(s). It will be appreciated that in certain embodiments, the remote computing server may retrieve the configuration file from a predetermined location, such as another server and/or storage device with which the remote computing server **150** may be configured to communicate via network **200** or other suitable communicative links.

At block **404**, remote computing resources may be allocated based at least in part on the received configuration file. The remote computing server **150** may, in one aspect, allocate the one or more remote computing resources **150**, **152**, **154**, **156**, **158** indicated in the received configuration file to provide the virtual machine **124** to the user **132**. In certain embodiments, the remote computing resources **150**, **152**, **154**, **156**, **158** may be located and dynamically allocated by the remote computing server **150** to provide the associated virtual machine **124**. The remote computing server **150** may further notify the user **132** when the user's virtual machine **124** has been configured. In the case of a reconfiguration of an existing virtual machine **124** implementation, remote computing resources **150**, **152**, **154**, **156**, **158** may be released and/or allocated based at least in part on the received configuration file without disruption or otherwise interruption in the user's ability to access the corresponding virtual machine **124**. In certain embodiments, the user **132** may experience a temporary disruption of remote computing services while the user's virtual machine is reconfigured by the remote computing servers **150**.

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At block 406, the remote computing server may update one or more remote computing resource tracking databases. This database may be stored in memory 190, database 156, or any other suitable location. This process may be optional, since in some embodiments, the tracking of the allocated remote computing resources 150, 152, 154, 156, 158 may be performed by the configuration servers 154. At block 408, the virtual machine may be provided to the user. The virtual machine 124 may be configured according to the received configuration file.

It should be noted that the method 400 may be modified in various ways in accordance with certain embodiments. For example, one or more operations of the method 400 may be eliminated or executed out of order in other embodiments. Additionally, other operations may be added to the method 400 in accordance with other embodiments.

Referring now to FIG. 5, an example method 500 to generate a configuration file providing remote computing resource pricing and receiving a selection of remote computing resources, in accordance with embodiments of the disclosure is discussed. The method 500 may be performed by the configuration servers 154 in cooperation other entities of architecture 100. Method 500 may be an example implementation of process 306 of method 300 of FIG. 3. At block 502, an indication of the availability of one or more remote computing resources may be received. In some cases, the configuration server 154 may access one or more remote computing resource databases to assess which remote computing resources 150, 152, 154, 156, 158 are available and/or utilized. These databases may be stored in the memory 170, storage device 156, or other storage entities associated with architecture 100. In certain embodiments, the configuration server may receive a message indicative of available remote computing resources 150, 152, 154, 156, 158 from one or more other entities, such as the remote computing servers 150.

At block 504, on or more remote computing resource pricing models may be identified. These models and/or algorithms may utilize any suitable pricing techniques and may consider a variety of factors to ascribe a price to the utilization or rental of each of or groups of remote computing resources 150, 152, 154, 156, 158. The parameters that may be considered may be the current availability, current utilization, cost, expected future cost, lead time, current demand, expected demand, and/or price elasticity of demand of remote computing resources 150, 152, 154, 156, 158. In some further cases, the remote computing resource pricing models may consider the availability of complimentary or substitutional remote computing resources 150, 152, 154, 156, 158. The remote computing resource pricing models may be provided, in certain embodiments, to price remote computing resources 150, 152, 154, 156, 158 to achieve an optimized and/or near optimized revenue and/or profit for the provider of remote computing services. In other embodiments, the remote computing resource pricing models may be provided to price remote computing resources 150, 152, 154, 156, 158 to control the demand of the remote computing resource and thereby ensure availability of key remote computing resources 150, 152, 154, 156, 158.

At block 506, a price may be determined for each of the remote computing resources based at least in part on the availability of the remote computing resources and the identified remote computing resource pricing models. This process, in certain embodiments, may entail applying the algorithms associated with the pricing models to a tally of the available remote computing resources 150, 152, 154, 156, 158. At block 508, remote computing resources with the

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determined corresponding pricing may be offered to the user for selection. This may be performed by transmitting an indication, either directly or indirectly, of the available remote computing resources and corresponding respective prices to the user's user device 128 for presentation to the user 132, such as in a graphical format on a user interface. The indication of the available remote computing resources may be transmitted in the form of one or more data packets via the networks 120 or other suitable communicative links.

At block 510, a selection of resources may be received from the user device. The selection may be received via the networks 120 in the form of one or more data packets either directly or indirectly from the user device 128. The selection of remote computing resources 150, 152, 154, 156, 158 may be responsive to the user 132 being presented with the available remote computing resources 150, 152, 154, 156, 158 and corresponding respective prices as determined at block 506.

At block 510, a selection of remote computing resources may be received from the user. The selections may be received in the form of one or more data packets transmitted either directly or indirectly via the networks 120 or other suitable communicative links. In certain embodiments, the configuration server 154 may determine if the received selections result in a feasible virtual machine 124 configuration. In other words, the configuration server 154 may determine if the selected remote computing resources 150, 152, 154, 156, 158 can be combined to provide a virtual machine 124. In one aspect, it may be determined if the configuration as selected makes efficient use of the remote computing resources that have been selected by the user 132. If the selections do not correspond to a feasible virtual machine configuration, then the configuration server 154 may provide an indication of the same to the user 132 via the user device 128 and the networks 120 or other suitable communicative link.

At block 512, a configuration file may be generated based at least in part on the selection of remote computing resources. The configuration file may be in the form of one or more data packets and may be indicative of the selection of remote computing resources 150, 152, 154, 156, 158 by the user 132 for the purposes of configuring the virtual machine 124. In certain embodiments, the configuration file may be indicative of a set of remote computing resources 150, 152, 154, 156, 158 that can be combined to provide a feasible virtual machine 124 implementation. In these embodiments, the configuration servers 154 and the processors 160 thereon may perform a determination that the selected remote computing resources may be combined in a feasible virtual machine 124 instance. The configuration file, once generated, may be provided to the remote computing server, as depicted in block 310 of method 300 of FIG. 3. It will be appreciated that in certain embodiments, an indication of the user 132 selection of remote computing resources 150, 152, 154, 156, 158 may be provided in a form other than the a configuration file.

It should be noted that the method 500 may be modified in various ways in accordance with certain embodiments. For example, one or more operations of the method 500 may be eliminated or executed out of order in other embodiments. Additionally, other operations may be added to the method 500 in accordance with other embodiments.

Referring now to FIG. 6, another example method 600 for selecting between two different prices for a resource and providing a configuration file based on a user selection of the remote computing resource, in accordance with embodiments of the disclosure. The method 600 may be performed by the configuration servers 154 in cooperation other entities of architecture 100. Method 600 may be an example imple-

mentation of process 306 of method 300 of FIG. 3. At block 602, an indication of the availability of a remote computing resources may be received. In some cases, the configuration server 154 may access one or more remote computing resource databases to assess the availability of the computing resource 150, 152, 154, 156, 158. These databases may be stored in the memory 170, storage device 156, or other storage entities associated with architecture 100. In certain embodiments, the configuration server 154 may receive a message indicative of availability of the remote computing resource 150, 152, 154, 156, 158 from one or more other entities, such as the remote computing servers 150.

At block 604, it may be determined if the availability of the remote computing resource is greater than a corresponding threshold value. The threshold value may be a value under which the number of the remote computing resource 150, 152, 154, 156, 158 may be considered relatively scarce. In certain embodiments, the remote computing service provider may consider reducing the demand by increasing the pricing of the resource when the availability of the remote computing resource 150, 152, 154, 156, 158 drops below this threshold. If at block 604 it is determined that the availability of the remote computing resource is not below the corresponding threshold value, then the remote computing resource price may be set to a first value at block 606. If, however, at block 604 it is determined that the availability of the remote computing resource is below the corresponding threshold value, then the remote computing resource price may be set to a second value at block 608. In certain embodiments, the second value may be greater than the first value.

At block 610, the remote computing resource with the determined corresponding price may be offered to the user for selection. This may be performed by transmitting an indication, either directly or indirectly, of the availability of the remote computing resource 150, 152, 154, 156, 158 and corresponding respective price to the user's user device 128 for presentation to the user 132, such as in a graphical format on a user interface. The indication of the available remote computing resource may be transmitted in the form of one or more data packets via the networks 120 or other suitable communicative links.

At block 612, it may be determined if the remote computing resource has been selected. If the user 132 has not indicated the remote computing resource 150, 152, 154, 156, 158 in the selection then the method may return to block 602 to again receive an indication of the availability of the remote computing resource. If, however, the user 132 has indicated the remote computing resource 150, 152, 154, 156, 158 in the selection then the method may proceed to block 614 where the configuration file may be generated to indicate the selections of the remote computing resource. At block 616, the configuration file may be transmitted. The configuration file may be transmitted either directly or indirectly to the remote computing servers 150 by the configuration server for the purpose of configuring the virtual machine 124.

It should be noted that the method 600 may be modified in various ways in accordance with certain embodiments. For example, one or more operations of the method 600 may be eliminated or executed out of order in other embodiments. Additionally, other operations may be added to the method 600 in accordance with other embodiments.

Referring now to FIG. 7, an example pricing engine 720 for providing a price for a variety of remote computing resources 150, 152, 154, 156, 158 in accordance with embodiments of the disclosure is discussed. A listing 710 of available remote computing resources with respective corresponding quantities of each of the remote computing resources may be

received and/or retrieved. The listing 710 of the remote computing resources may be applied to a pricing engine 720. The pricing engine may apply one or more pricing models and/or pricing algorithms to determine the price of each of the remote computing resources as shown as 730.

Referring now to FIG. 8, an example user interface 800 for selecting remote computing resources 150, 152, 154, 156, 158 to customize a virtual machine 124, in accordance with embodiments of the disclosure is discussed. This user interface 800 may be generated based at least in part on an assessment of the availability of various remote computing resources 150, 152, 154, 156, 158. An indication of available remote computing resources 808, 824, 830, 840 and associated pricing 812 and total selection pricing 816 may be presented on the user interface 800. The user interface 800 may also provide a variety of mechanisms 820, 834 with which the user 132 may interact to provide requested selections of remote computing resources 150, 152, 154, 156, 158 for the purposes of configuring the virtual machine 124.

Embodiments may be provided as a computer program product including a non-transitory machine-readable storage medium having stored thereon instructions (in compressed or uncompressed form) that may be used to program a computer (or other electronic device) to perform processes or methods described herein. The machine-readable storage medium may include, but is not limited to, hard drives, floppy diskettes, optical disks, CD-ROMs, DVDs, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, flash memory, magnetic or optical cards, solid-state memory devices, or other types of media/machine-readable medium suitable for storing electronic instructions. Further, embodiments may also be provided as a computer program product including a transitory machine-readable signal (in compressed or uncompressed form). Examples of machine-readable signals, whether modulated using a carrier or not, include, but are not limited to, signals that a computer system or machine hosting or running a computer program can be configured to access, including signals downloaded through the Internet or other networks. For example, the distribution of software may be an Internet download.

Although embodiments have been described in language specific to structural features and/or methodological acts, it is to be understood that the disclosure is not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as illustrative forms of implementing the embodiments. Conditional language, such as, among others, "can," "could," "might," or "may," unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments could include, while other embodiments do not include, certain features, elements, and/or steps. Thus, such conditional language is not generally intended to imply that features, elements, and/or steps are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without user input or prompting, whether these features, elements, and/or steps are included or are to be performed in any particular embodiment.

That which is claimed:

1. A system, comprising:

at least one memory that stores computer-executable instructions;

at least one processor configured to access the at least one memory, wherein the at least one processor is configured to execute the computer-executable instructions to:

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identify one or more remote computing resources and a corresponding respective level of availability of each of the one or more remote computing resources;
 determine a respective corresponding price of each of the one or more remote computing resources based at least in part on the corresponding respective level of availability of each of the one or more remote computing resources and one or more pricing models;
 provide an indication of the one or more remote computing resources and the respective corresponding price of each of the one or more remote computing resources;
 receive an indication of a selection of at least one of the one or more remote computing resources;
 determine, responsive at least in part to the indication of the selection, that a feasible configuration of the at least one of the one or more remote computing resources for a virtual machine has been selected;
 generate, responsive at least in part to the indication of the selection and determination that a feasible configuration has been selected, a configuration file; and transmit the configuration file.

2. The system of claim 1, wherein the one or more remote computing resources comprises at least one of: (i) a processor device; (ii) a memory device; (iii) a storage device; (iv) a graphical processing unit; (v) a hard disk drive; (vi) a solid state drive; or (vii) a networking device.

3. The system of claim 1, wherein the at least one processor is further configured to identify one or more pricing models.

4. The system of claim 3, wherein the one or more pricing models comprises at least one of: (i) a regression model; (ii) a machine learning model; or (iii) a stochastic model.

5. The system of claim 1, wherein at least one of the prices of each of the one or more remote computing resources is valid for a predetermined period of time.

6. The system of claim 5, wherein identifying the level of availability of each of the one or more remote computing resources comprises identifying that previously deployed remote computing resources are no longer deployed.

7. The system of claim 1, wherein the at least one processor is further configured to update a remote computing resource database to modify the availability level of each of the remote computing resources of the selection.

8. The system of claim 1, wherein the configuration file comprises an identifier of each of the selection of at least one of the one or more remote computing resource.

9. A method, comprising:
 receiving, by one or more computers comprising one or more processors, a configuration file identifying at least one remote computing resource, wherein the configuration file indicates that the at least one remote computing resource has been verified to be in a feasible configuration of the at least one remote computing resource for a virtual machine;
 identifying, by the one or more computers using the received configuration file, the at least one remote computing resource;
 allocating, by the one or more computers, the identified at least one remote computing resource to the virtual machine; and
 providing, by the one or more computers, the virtual machine to a user responsive at least in part to the allocation of the at least one remote computing resource, wherein the identification of the at least one remote computing resource is responsive at least in part to the user's selection of the at least one remote computing resource from a set of one or more remote computing

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resources and wherein the user is provided with a pricing of each of the one or more remote computing resources.

10. The method of claim 9, wherein the one or more remote computing resources comprises at least one of: (i) a processor device; (ii) a memory device; (iii) a storage device; (iv) a graphical processing unit; (v) a hard disk drive; (vi) a solid state drive; or (vii) a networking device.

11. The method of claim 9, wherein the configuration file comprises a unique identifier of each of the at least one remote computing resource.

12. The method of claim 9, further comprising updating, by the one or more computers, a remote computing resource database to modify an availability level of each of the at least one remote computing resource.

13. The method of claim 9, further comprising transmitting, by the one or more computers, a notification of the virtual machine to the user.

14. The method of claim 9, wherein the virtual machine is accessible via one or more application program interfaces (APIs).

15. At least one non-transitory computer-readable medium comprising computer-executable instructions that, when executed by one or more processors, executes a method comprising:
 identifying one or more remote computing resources;
 determining a respective corresponding price of each of the one or more remote computing resources;
 providing an indication of the one or more remote computing resources and the respective corresponding price of each of the one or more remote computing resources;
 receiving an indication of a selection of at least one of the one or more remote computing resources;
 determining that a feasible configuration of the selection of the at least one of the one or more remote computing resources for a virtual machine has been selected;
 generating a configuration file, responsive at least in part to determining feasibility of the selection of the at least one of the one or more remote computing resources; and
 transmitting the indication of the selection of the at least one of the one or more remote computing resources.

16. The non-transitory computer-readable medium of claim 15, wherein the one or more remote computing resources comprises at least one of: (i) a processor device; (ii) a memory device; (iii) a storage device; (iv) a graphical processing unit; (v) a hard disk drive; (vi) a solid state drive; or (vii) a networking device.

17. The non-transitory computer-readable medium of claim 15, wherein the method further comprises determining a corresponding respective level of availability of each of the one or more remote computing resources.

18. The non-transitory computer-readable medium of claim 17, wherein the providing the respective corresponding price of each of the one or more remote computing resources comprises identifying the level of availability of a first remote computing resource from the one or more remote computing resources and setting the price of the first remote computing resource at a first value if the level of availability is above a predetermined threshold or set the price at a second value if the level of availability is below a predetermined threshold.

19. The non-transitory computer-readable medium of claim 18, wherein at least one of the prices of each of the one or more remote computing resources is valid for a predetermined period of time.

20. The non-transitory computer-readable medium of claim 15, wherein the method further comprises identifying one or more pricing models.

21. The non-transitory computer-readable medium of claim 20, wherein the one or more pricing models comprises at least one of: (i) a regression model; (ii) a machine learning model; or (iii) a stochastic model.

22. The non-transitory computer-readable medium of claim 15, wherein the configuration file indicates an identity of a consumer for whom the selection of the at least one of the one or more remote computing resources is made.

23. The non-transitory computer-readable medium of claim 22, wherein the configuration file comprises an identifier associated with each of the selection of at least one of the one or more remote computing resource.

24. The non-transitory computer-readable medium of claim 15, wherein providing a price of each of the one or more remote computing resources comprises identifying the level of availability of each of the one or more remote computing resources.

25. The non-transitory computer-readable medium of claim 24, wherein the method further comprises updating a remote computing resource database to modify the availability level of each of the remote computing resources of the selection.

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